Application of GIS to Analyze Health Status of Selected Communities Kalasin Province, Thailand

Mahaweerawat, U.,[1] Yangyuen, S.,[1] Khamphilung, S.,[2] Somdee, T.,[1] Songklang, S.,[1] Wech-O-sotsakda, C.,[2] Thongkrajai, P.[3] and Pichainarong, N.[1]
[1]Faculty of Public Health, Mahasarakham University, Maha Sarakham 44150, Thailand
E-mail: m_udomsak@yahoo.com, suneeratyang1@hotmail.com
[2]Faculty of Informatics, Mahasarakham University, Maha Sarakham 44150, Thailand
[3]Faculty of Medicine, Mahasarakham University, Maha Sarakham 44150, Thailand

Abstract
The aim of this cross-sectional design was to analyze health status of the population currently residing in three selected communities in northeastern province of Thailand with use of a Geographic Information System (GIS) Program. The study included 70 representatives household randomly selected from three target communities of Krainoon Subdistrict (village cluster number namely: Moo 1, Moo 8, and Moo 11) in Hauy Pueng District, Kalasin Province. Data were collected by using (i) an interview guide comprising of household composition, socio-economic and cultural background, health and health related information, as well as environmental health conditions and, (ii) satellite digital file image with input scoped ratio of 1:250,000 located as GPS (Global Positioning System) on virtual high precision for spatial information in relation to area location and a database on households and related information under study. After application of the Arc-View GIS Program, results showed linkages between location of the study communities and the database on composition, socio-economic and cultural background, as well as health and other related information of each household separated by community. All of the information in such database was designed to be modified and updated. In addition, the database was made easily available for the users in all parts of the household community. Linking the database of health related information with spatial information of households and communities will be useful for health personnel and authorities in the area to evaluate health status of the population and to find appropriate means to effectively disseminate information and innovation to their target population in both household and community levels.

1. Introduction

The Primary Care Unit (PCU) has an important role to provide basic health care services accessible for the grass roots population. Health care providers are simultaneously responsible for health and well being of the population in an area at all levels, including individual, family and community. The Ministry of Public Health of Thailand has launched thier health care service standard for a PCU to achieve the tasks since 2002. The important health care service standards for a PCU are: generating the use of a family folder system to record information such as basic health background and other related information for all members in each family and generating the folder system as community characteristics, area location map, population composition and health status (Department of health service support, 2002). Both family and community folder systems are collected and a record is kept in various forms, either in paper documents or computer files with the use of software program created by the Ministry of Public health. However, lack of integration of information and linkage of health and spatial information, particularly for a specific location creates difficulties for health care providers to compare across families and communities (Health Care Development Bureau Ministry of Public Health, 2002). Therefore, it is essential to increase the database of health care personnel to be able to analyze data while integrating all relevant information and linking it with spatial background of each target family and community for effective health solutions in a timely fashion. Geographical Information System (GIS) and its software program are important tools to facilitate the integration of relevant background of each community with its spatial area location to be analyzed, updated and displayed such combined information in a visible form (Yongsirivit, 2004). This research is aimed at the application of the GIS Program into a PCU's health care service tasks, particularly for family and community folder systems. Findings from this research serve as a novel innovation to facilitate health care personnel at PCU level to make more effective entering and

updating data as well as analyzing the data. Hence, this integrated information will be useful for health personnel and related authorities to verbally and quickly inform on health and related issues. As a consequence, it will increase the ability of the health and related authorities to find effective and timely ways to assist to health situations and problems of a population in which they serve.

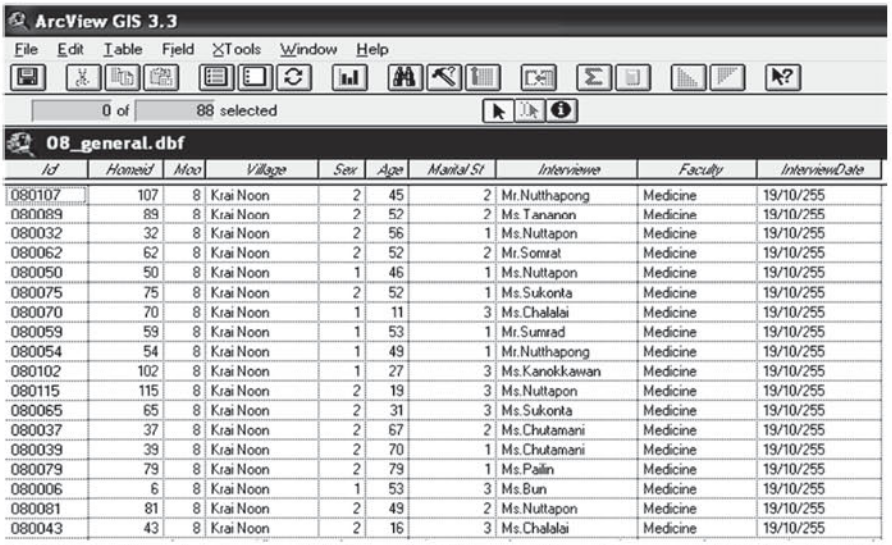
2. Material and Method

This cross – sectional descriptive study applied the Arc-View GIS Program under the license issued for the Department of Information Science, Faculty of Informatics at Mahasarakham University of Thailand and was carried out from October 2008 till September, 2009. Data collection included the use of an interview guide from the 70 representative of households randomly selected by means of stratified random sampling based according to size of each of the three study villages located in Krainoon sub-district, Hauy Pueng district of Kalasin province, northeastern Thailand. The questionnaire was modified from the community survey questionnaire suggested by the World Health Organization (WHO) and comprised four parts, Data on spatial information was also collected and recorded by using the Arc-View GIS 3.1 software program which operated through the use of satellite digital image file with input ratio 1:250,000 located on GPS with virtual high precision, The Land development division of Agricultural and Co-operation Ministry's top view Airplane image ratio 1:25,000 and government's interior geographical map ratio of 1:50,000 which covered the study area as top-view image preliminary identified modified locations. The data was analyzed by using descriptive statistics such as frequency, mean, standard deviation, and percentage, socioeconomic condition, cultural and environmental background, as well as health and health related information of the studied households. This information was then combined with spatial information of each location. Then combined information was also available in various forms, such as tables, descriptive contents, and pictures specifically for each household and community. In addition, such study program was also made possible for data processing, updating, retrieving, and searching.

3. Results

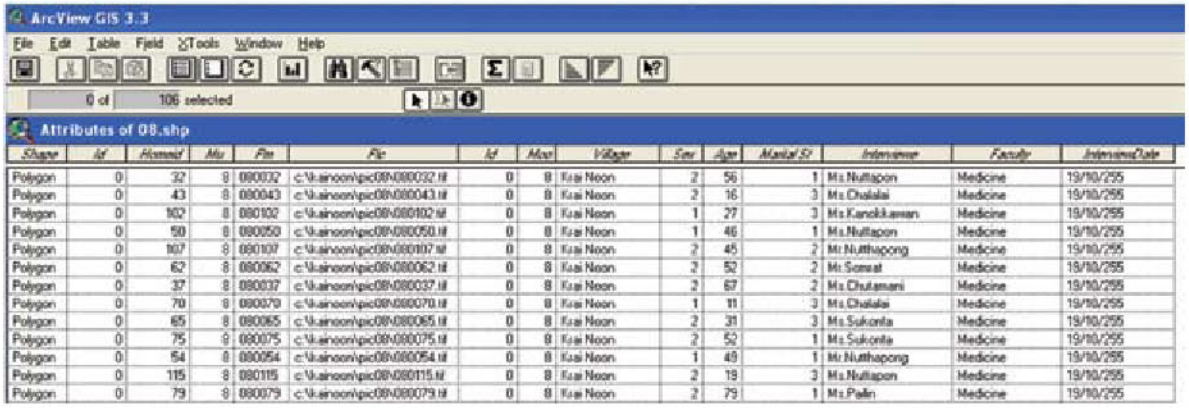
3.1 Processes and steps related to the application of the GIS program in analyzing population health in the study communities

This initial process involves input data, particularly satellite digital file image, which they received permission from the Land Development Department of the Agriculture and Co-operation Ministry, Thailand. Results show satellite digital image files derived from the Arc-View software program. These pictures reflected landscape and spatial information in relation to household composition and health related issues (see figures 1-3). In addition, being able to store and keep information in the forms of extended files, made it possible for users to add or modify all parts of information and to digitize data the related data to current spatial pictures. GIS application was seen beneficial as could be used for effective database management.



Id	Homeid	Moo	Village	Sex	Age	Marital St	Interviewe	Faculty	InterviewDate
080107	107	8	Krai Noon	2	45	2	Mr.Nutthapong	Medicine	19/10/255
080089	89	8	Krai Noon	2	52	2	Ms.Tananon	Medicine	19/10/255
080032	32	8	Krai Noon	2	56	1	Ms.Nuttapon	Medicine	19/10/255
080062	62	8	Krai Noon	2	52	2	Mr.Somrat	Medicine	19/10/255
080050	50	8	Krai Noon	1	46	1	Ms.Nuttapon	Medicine	19/10/255
080075	75	8	Krai Noon	2	52	1	Ms.Sukonta	Medicine	19/10/255
080070	70	8	Krai Noon	1	11	3	Ms.Chalalai	Medicine	19/10/255
080059	59	8	Krai Noon	1	53	1	Mr.Sumrad	Medicine	19/10/255
080054	54	8	Krai Noon	1	49	1	Mr.Nutthapong	Medicine	19/10/255
080102	102	8	Krai Noon	1	27	3	Ms.Kanokkawan	Medicine	19/10/255
080115	115	8	Krai Noon	2	19	3	Ms.Nuttapon	Medicine	19/10/255
080065	65	8	Krai Noon	2	31	3	Ms.Sukonta	Medicine	19/10/255
080037	37	8	Krai Noon	2	67	2	Ms.Chutamani	Medicine	19/10/255
080039	39	8	Krai Noon	2	70	1	Ms.Chutamani	Medicine	19/10/255
080079	79	8	Krai Noon	2	79	1	Ms.Pailin	Medicine	19/10/255
080006	6	8	Krai Noon	1	53	3	Ms.Bun	Medicine	19/10/255
080081	81	8	Krai Noon	2	49	2	Ms.Nuttapon	Medicine	19/10/255
080043	43	8	Krai Noon	2	16	3	Ms.Chalalai	Medicine	19/10/255

Figure 1: Attribution of data exported from the Microsoft Excel program into the Arc-View GIS program using the "field" function, entitled, "Home ID" as the core field in the sorting



Shape	Id	Homeid	Mu	Pic	File	Id	Moo	Village	Sex	Age	Marital St	Interviewer	Faculty	InterviewDate
Polygon	0	32	8	080032	c:\kainoon\pic08N080032.tif	0	8	Kai Noon	2	56	1	Ms.Nuttapon	Medicine	19/10/255
Polygon	0	43	8	080043	c:\kainoon\pic08N080043.tif	0	8	Kai Noon	2	16	3	Ms.Chalalai	Medicine	19/10/255
Polygon	0	102	8	080102	c:\kainoon\pic08N080102.tif	0	8	Kai Noon	1	27	3	Ms.Kanokkawan	Medicine	19/10/255
Polygon	0	50	8	080050	c:\kainoon\pic08N080050.tif	0	8	Kai Noon	1	46	1	Ms.Nuttapon	Medicine	19/10/255
Polygon	0	107	8	080107	c:\kainoon\pic08N080107.tif	0	8	Kai Noon	2	45	2	Mr.Nutthapong	Medicine	19/10/255
Polygon	0	62	8	080062	c:\kainoon\pic08N080062.tif	0	8	Kai Noon	2	52	2	Mr.Somrat	Medicine	19/10/255
Polygon	0	37	8	080037	c:\kainoon\pic08N080037.tif	0	8	Kai Noon	2	67	2	Ms.Chutamani	Medicine	19/10/255
Polygon	0	70	8	080070	c:\kainoon\pic08N080070.tif	0	8	Kai Noon	1	11	3	Ms.Chalalai	Medicine	19/10/255
Polygon	0	65	8	080065	c:\kainoon\pic08N080065.tif	0	8	Kai Noon	2	31	3	Ms.Sukonta	Medicine	19/10/255
Polygon	0	75	8	080075	c:\kainoon\pic08N080075.tif	0	8	Kai Noon	2	52	1	Ms.Sukonta	Medicine	19/10/255
Polygon	0	54	8	080054	c:\kainoon\pic08N080054.tif	0	8	Kai Noon	1	49	1	Mr.Nutthapong	Medicine	19/10/255
Polygon	0	115	8	080115	c:\kainoon\pic08N080115.tif	0	8	Kai Noon	2	19	3	Ms.Nuttapon	Medicine	19/10/255
Polygon	0	79	8	080079	c:\kainoon\pic08N080079.tif	0	8	Kai Noon	2	79	1	Ms.Pailin	Medicine	19/10/255

Figure 2: Result derived from sorting GIS spatial information with household characteristics and demographic data

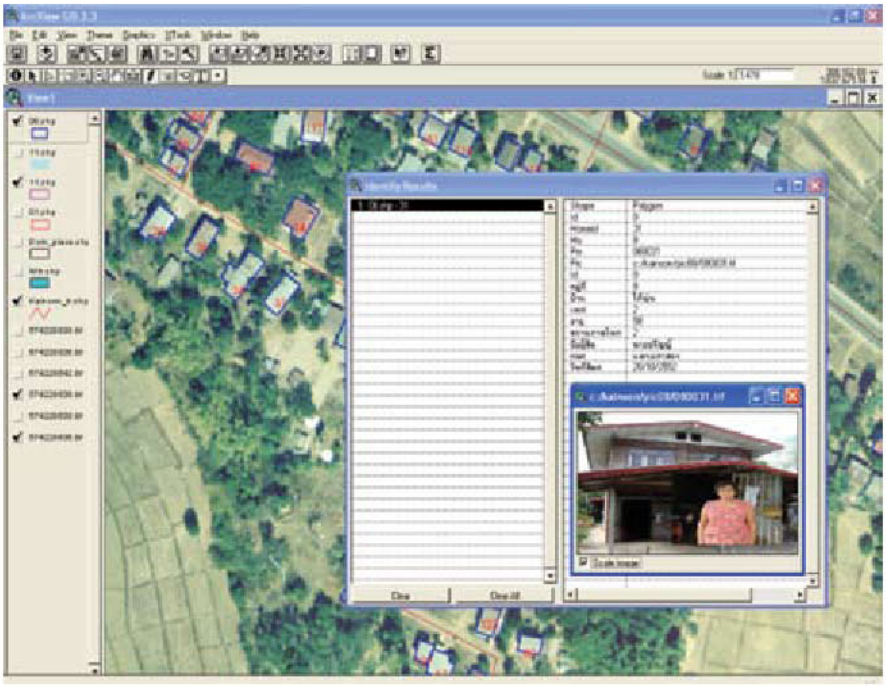


Figure 3: Example of the Identified Results of an interviewed from the house number 31 of Moo 8 in corporation with spatial information displayed in a picture depicting the interviewer and her residential home

3.1.1 Baseline data on description of household and health related characteristics deriving from the study interview guide

In this sub-process, data from questionnaire, which was previously entered into Microsoft Excel, would be exported in the form of Data Base File type (*.DBF). This file was made for the possible merging with spatial information available in the Arc-View GIS program

3.1.2 Incorporate sorting of data on spatial with household characteristic description

After incorporating data from the Microsoft Excel file into the Arc-View GIS program, each part of household information was merged with spatial information using high resolution satellite image file. In this sub-process, the researcher has applied relational database properties by indicated function key for sorting pop-up field menu. There are two categories of the pop menu linkages in this study.

3.1.2.1Temporary sorting

This temporary sorting reflects the relation of two sets of information performed by the users with query towards completeness of information. After data completion, users can perform task using remove join function, merging of the two sets of data will be separated.

3.1.2.2 Permanent sorting

This category of relation reflects unable to abolish sorting. In other words, such category of linkage is the one that is performed with the aim at constructing new database. Results derived from each sorted part of the information related to household characteristics and health conditions are shown in figures 1-3

3.1.3 Searching, modifying and displaying household information searching household information

After combining two sets of information mentioned earlier, users are able to search for household information by using either keyword or specific characteristic of interest. There are two categories of searching in the GIS are as the following.

3.1.3.1 Searching by spatial data

To search data, users can choose the icon "Identify Results" and then click on the selected household, which is seen as a box on a spatial map visible on the monitor screen. As a result, description of related information of the selected household will be seen by users based on the relational database previously set by the researchers. For example, if the user clicks on the red box representing household number 52, the box will then turn yellow indicating that the user is currently inquiring for a selected household. Data on the figure 4 show results when user inquires data using "Query" function. Information of the selected household will be seen by the user, including household composition and health related information previously entered in the program. In addition, user can search for information of a specific household by the name of an interviewee who is a representative of each study household.

3.1.3.2 Searching by direct attribute

This category of searching can be done by opening the table containing relational database previously set by researchers. For example if user clicks onto a particular row or record, then the icon representing the selected household will be seen as house number and is turned to identified difference color block. Data is shown in figure 5 (house hold No 48).

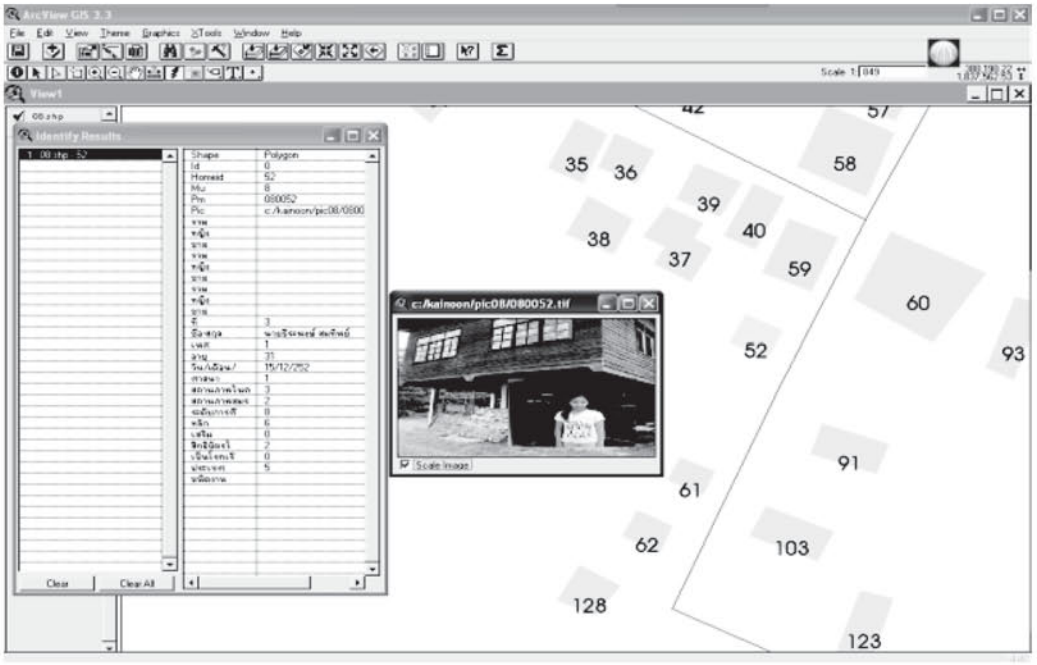


Figure 4: Appearance of the result deriving from searching by spatial or area location of a specific household using house number

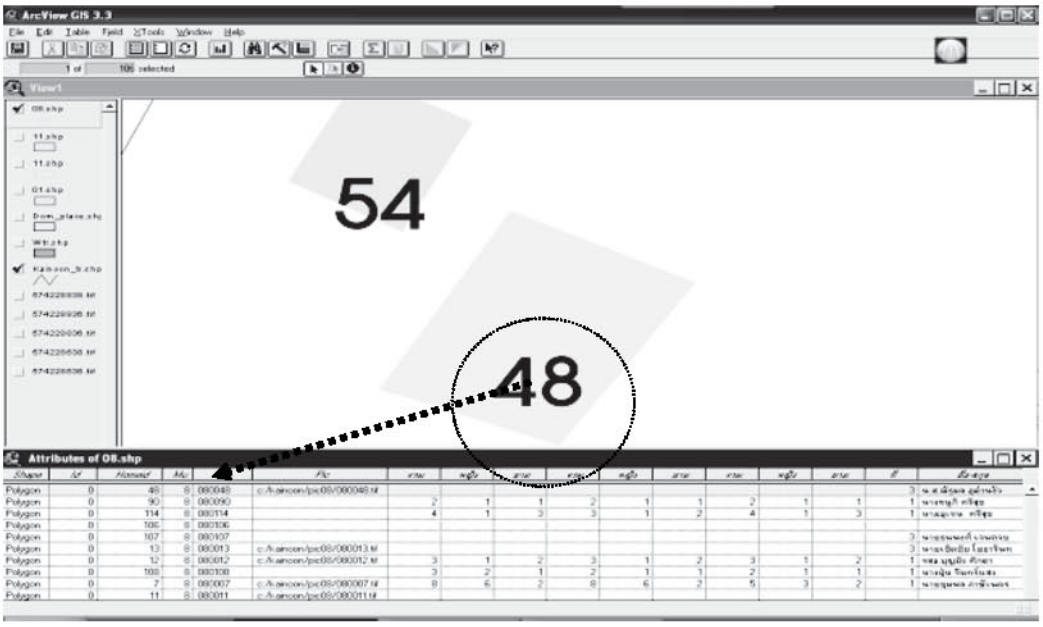


Figure 5: Result from searching by using database table

4. Discussion

Application of GIS to combining health status of the population residing in three selected communities of study area provides new way to modify information in documentary forms or digital files of certain software programs into spatial related database form. This increases the ability of users, particularly health care providers, to search, analyze and display health and health related database of the population in the community incorporation with spatial information. Results from the relational information, which provides both database in relation to map of location, is seen beneficial to health and related authorities working in the area as it helps locating places of health problems and risk groups of as well as to helps evaluating needs and prioritizing preventive solutions that need to be allocated or reallocated within different households or communities. In the relation of agricultural Changes, Water Quality and Health: Investigating the Health Status of Populations living in an Agricultural Irrigated Area, using Spatial Analysis, in Phrae Province, Thailand Herbreteau et al (2006). The results show that the increasing use of chemical fertilizers and pesticides (mostly insecticides and weed killers) in agriculture area has some health consequences, as cases of pesticide poisoning are also increasingly recorded over the country by the MOPH, shown a significant correlation with the quantity of pesticides utilized. Most of the infectious diseases are reported as diarrheas that might be cause of various origins but possibly linked to water quality. Spatial approaches of the health status, Populations are also living with lower incomes and may have a limited recourse to received health care services. Within the irrigated area, villages upstream show higher incidences than those long spread as 2 kilometers downstream for diarrhea (up to 2 times higher), conjunctivitis and food poisoning. Leptospirosis incidences figure vary from one village to another every year. Higher incidences were also recorded in the villages surrounded by rice fields. Understanding the consequences of environmental and especially agricultural changes on health needs long term investigations to observe and measure the dynamics. However, some signs can already be interpreted. Spatial analysis enabling different scales of study has proved to be a real support of analysis showing unknown radical differences in incidence a few kilometers apart, which cannot be observed with aggregated other geo-referenced data scaling. The result is useful for authorities, in both the current situation and in near future, so as to come up with new ways of seeking information about health existing in an area, thereby decreasing misinterpretation of poor quality information and increasing their abilities to solve health problems systematically and in an integrated way. Application of GIS in facilitating health services in the community is seen appropriate as it conforms to national policies, particularly those of the Ministry of Public Health (MOPH) Thailand

(Bureau of information, Ministry of public health, 2008).

The MOPH has applied GIS in various works, which includes epidemiological survey and monitoring for disease control and prevention, health care service analysis such as resource allocation, distribution of health care facilities, and accessibility to health care services. Such information is vital for the MOPH to appropriately plan for resource allocation and budgeting with equity and to provide health care facilities with highest coverage. In the same methodology of Health Information System - For Rural Health Planning, Pudukkottai District, Tamil Nadu, India found that in the Health Information System (HIS), a hierarchy of village wise data were collected on the hospitals, doctors, supporting staff, diseases, patients, etc, Ramasamy et al (2006). A unique information retrieval system was developed using which, the planners / users can access any type of above data, on the village wise availability and reachable of above various medical facilities and data on patients, diseases, etc. Certain special provisions have also been made in HIS' for easy and effective planning. The paper discusses briefly the same direction. Therefore, continuity of collecting data to be used as input information in such a system needs to be maintained. However, the tasks involved in sustaining the information system were problematic, particularly data collection system, methods of data collection and analysis. Furthermore, limitations on capacity of working personnel, availability of tools and software programs were also seen impairing health information system. Such factors conformed to the study conducted by Sintupat (2005). The application of the GIS was also witnessed in the research study by Choompolkul (2006). Database on dental fluorosis linking spatial information in such a study successfully showed dentition problem based on area location, thereby enhancing abilities of health policy makers to plan for better effective solutions suitable for the needs of a population in each locale. Yagoub (2011) Geographic Information Systems (GIS) Application for Health: Case of Al Ain (UAE) the results show that Geographic Information Systems (GIS) helped in linking the cases at clinics with population density, hence it provided a multi-layer analysis abilities, GIS also provides a better modeling and visualization of the cases in spatial-temporal dimension. People who work in public and environmental health can get use of this study to demonstrate the applicability of GIS for analyzing health data. However, it is also important to keep in mind that effective use of the GIS incorporation with health databases needs not only accurate data, appropriate hardware and software programs but also knowledgeable and skillful personnel as well as uncomplicated processes and steps in system operation (Youmuang ,2004).

5. Conclusion

The community health status profiles of the villages and other health related data of population in relation to spatial information based on an application of the GIS program was constructed to facilitate the works of health care providers as the major users. This relational health database was also aimed at increasing capacity of the health care providers to plan for coverage and effectively provisioning of health services in all levels. It is important to note that sustainability, continuity and timeliness of any health relational database system needs skilled personnel for any process, as well as linking particular database with spatial information. Application of the GIS and its software program serves as one of the supportive tools to facilitate the work of users.

Acknowledgement

The researchers wish to give our deep gratitude to the Mahasarakham University for provisioning of the supportive. Our heartfelt thanks also go to all household representatives and members of the communities (Moo 1, Moo 8, and Moo 11) of Krainoon subdistrict, Hauy Pueng district, Kalasin province for their cooperation and for their kind help. Finally, we would like to thank all of the leaders of the three communities along with administrator and this administrative team members and officers related.

References

Bureau of Information, Ministry of Public Health, 2008. *Geographic information systems and mapping on area of health risk* .http://www.moph.go.th/ops/iprg/iprg_new/include/admin_hotnew/show_hotnew.php?idHot_new=12165

Choompolkul, W., 2006, Application of the Dental Fluorosis Monitoring System by using Geographic Information in Patan Village, Banthi District, Lamphun Province. Chiang Mai University, Thailand.

Department of Health Service Support, 2002, *Mamual of Primary Health Care Unit Standard Evaluation And Quality Assurance*. Bangkok: Ministry of Public Health, Thailand.

Health Care Development Bureau, 2002, Folder Guide: Health Information System under

Universal Coverage Health Insurance Project. Bangkok: Ministry of Public Health, Thailand.

Herbreteau, V., Gonzalez, J. P., Khaungaew, W., Salem, G. and Janeau, J., 2006, Agricultural Changes, Water Quality and Health: Investigating the Health Status of Populations living in an Agricultural Irrigated Area, using Spatial Analysis, in Phrae Province, Thailand. *International Journal of Geoinformatics*, 2(4), 23-28.

Ramasamy, S. M., Kumanan, C. J., Palanivel, K., Gayathri, D. and Pushpamalar, P., 2006, Health Information System - For Rural Health Planning, Pudukkottai District, Tamil Nadu, India. *International Journal of Geoinformatics*, 2(4), 65-72.

Sintupat, K., 2005, *The Application of Geographic Information System for Field Work Planning of Reducing Youth Drug-Related HIV/STD Risk in Northern Thailand Project of Research Institute for Health Science*. Chiang Mai University, Thailand.

Yongsirivit, T., 2004, *Geographic Information Systems and Health Service*. Information & Communication Technology Center. Bangkok: Ministry of Public Health, Thailand.

Yagoub, M. M., 2011. Geographic Information Systems (GIS) Application for Health: Case of Al Ain (UAE). *International Journal of Geoinformatics*, 7(1), 21-28.

Youmuang, S., 2004, *GIS application for HPAI Management in Thailand*. Bangkok: Chulalonkorn University, Thailand.